

# Remarks on Fluid and Kinetic Thermal Forces for Plasma Edge Transport Codes

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The effect of thermo diffusion has been discovered by David Enskog exactly a century ago during his doctoral thesis. In fusion research the thermal force is necessary for a proper description of impurity transport processes in the scrape off layer plasma. Thus common plasma edge transport codes account for this effect, which can be modelled either in the fluid or in the more accurate kinetic approach. An example of a simple 1D fluid model including this effect is the one by Neuhauser [1]. His model allowed him to deduce a criterion for divertor leakage, which he found to be a balance between friction and thermal forces. A widely used impurity transport code, which is in between the fluid and the kinetic approach, is DIVIMP [2]. Therein the thermal force is not represented kinetically, but with a fluid force converted to act on a single particle. Reiser introduced a model which treats the thermo force more fundamental from the collision point of view in Ref. [3]. A similar approach has been worked out in Ref. [4], which differs from Reiser's model in the type of polynomial series used to reconstruct the background plasma distribution function. In previous studies the three different models have been compared from the theoretical viewpoint, but what is still missing is a practical look on the range of application for fusion edge plasmas. For this purpose the simple model developed by Neuhauser for impurity transport will be taken as a fluid reference and compared to the most basic DIVIMP particle transport model (see chapter 6 in Ref. [2]) and then to the more advanced kinetic approach from Reiser, which has been recently improved and incorporated into the EIRENE code [5]. Scrape off layer parameters are sought where the three different approaches match. Moreover the limits of the fluid approach are discussed and when the quasi kinetic DIVIMP approach is required, and furthermore when a complete kinetic treatment, with e.g. the extended EIRENE code, is desirable.

[1] J. Neuhauser et al, J. Nuclear Fusion, Vol. 24, 1984

[2] P. Stangeby, The Plasma Boundary of Magnetic Fusion Devices, Inst of Physics Pub 2000

[3] D. Reiser et al, J. Nuclear Fusion, Vol. 38, 1998

[4] K. Shimizu et al, J. Nucl. Mat. 390-391, 2009, 307-310

[5] J. Seebacher, PhD Thesis, University of Innsbruck, 2009